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RELATION OF COLD STORAGE TO THE FOOD SUPPLY AND THE CONSUMER

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The great industrial revolution that has swept the nation has placed the consumer in a new position. He is now uncommonly ignorant of many things that were formerly commonplace. The clothes on his back used to come from his own sheep, and were spun, woven and made up by the women of the household. Each housewife knew the whole history of most of the articles that were used by the members of her family. Now, the great woolen industries are so complex that the men who lead them can be expert only in certain branches. With the complexity and the division of labor that have arisen in manufactures have come a like differentiation and series of problems in the production, distribution and equalizing of the food supply. The nearby farms can no longer supply the contiguous city with the foodstuffs which it demands. Indeed, in many instances, the farmer himself purchases supplies to supplement his own productions, or to give his family the delicacies that are out of season or furnished by a different environment.

The revolution in the conditions influencing the food supply of the nation is as widespread, as deep and far more important than the revolution in the manufacturing industries. To live, the nation must eat, and to be strong, virile and progressive the food must be wholesome and plentiful. The food supply is the most fundamental question that the modern world has to face, yet it is a subject on which the average well informed person is lamentably ignorant. This is very largely due to a clinging to the old ideas concerning quality that prevailed when the nearby farm was the source of supply and when "freshness" was measured by the number of hours that elapsed between the gathering of the produce and its delivery to the consumer. The fewer the hours, then, the better the goods, because the farmer

had no facilities for preventing decay, nor did he know how to handle his wares so as to lengthen their keeping time.

Because the consumer has insisted that he must have produce "right fresh from the country," the vendor has imposed upon his ignorance by pretending to give it to him. In reality the vendor cannot obtain such goods as his customer demands, hence the falsehoods that are a part of the stock in trade of every retailer.

The consumer is justified in rebelling against the falsehoods; and the produce-man can just as strongly insist that the consumer shall inform himself about the conditions governing the food supply, especially in the great cities, and not make almost every sale contingent upon an untruth. The conditions which the consumer, because of lack of knowledge, imposes upon the vendor are very largely responsible for the almost universal ignorance that prevails today concerning the preservation of perishable products by low temperatures, and which is commonly called "cold storage." It may be well, therefore, for those interested in the complex problems of the present day, to find out just what relation cold storage bears to modern life; what is its effect on food products from the viewpoint of wholesomeness and palatability; to what extent has it developed and what caused this great industry to spring up within the last twenty-five years.

Before these questions are discussed, however, it may be well to state specifically what a modern cold storage warehouse is. Many people infer that ice is used as a refrigerant. Ice is never used. Its refrigerating power is far too low, and the basic requirements of a modern refrigerated warehouse are incompatible with the use of ice. Refrigeration is produced by mechanical means and distributed by pipes carrying a calcium chloride brine, or liquid ammonia, in which the temperature may be -20° F. The cold from these pipes diffuses into the rooms to be chilled, and the temperature desired is obtained by a more or less rapid flow of the cold liquid in the pipes. The air of the rooms is necessarily dry, since the low temperatures condense the moisture of the air into snow. The temperatures usually maintained range from about 40° F. in the case of some vegetables, to -10° F. which is used for butter, and sometimes fish. Eggs are carried at 29° F. to 31° F. (an egg freezes at about 28° F.) and poultry and meat at approximately 10° F.

The more recently built warehouses are of concrete construction with cork or mineral wool insulation. The old type of warehouse was

of brick, wood lined, and insulated with shavings, sawdust, paper, etc. These old houses are not economical and it is a difficult matter, comparatively, to keep the air in them sweet and fresh. They are rapidly being replaced by houses of the concrete type. Current opinion holds that cold storage warehouses are dirty, insanitary places. The fact of the case is that they are, almost without exception, far cleaner than the butcher's ice-cooled box, and infinitely ahead of the house refrigerator, as commonly kept by the present day servant. The usual newspaper description of the cold store is not based on observation but on the imagination of the reporter in response to the demand for sensational headlines.

The question of wholesomeness is, of course, the most important, and the phase of the subject that has received the greatest amount of study. Fortunately for the public health the majority of these researches have been made by chemists and bacteriologists in the quiet unconcern of their laboratories; unfortunately for the education of the public the results have been published only in the scientific journals; or, in abstract, in the trade publications of the industries involved.

Many foodstuffs protected from decay by low temperature are such stable articles that one does not question their fitness for consumption after months of such preservation. For example, cereals and nuts are cold stored to guard against weevil and other vermin. Again, many commodities, especially of the hardy vegetable or fruit types, are preserved in the farm cellars, or pits, for months. We are, therefore, accustomed to having potatoes, celery, cabbage and apples out of their seasons and accept their presence in the accurately regulated public chill room as a proper provision to insure good condition to the consumer and an equalized supply.

Meats, fish, poultry, butter and eggs, on the other hand, the consumer knows only as extremely perishable products, unfit for consumption in a very short time after reaching his hands. From the scant knowledge which he possesses of the handling of perishables he has not imagined the care and cleanliness with which foodstuffs are prepared to avoid bacterial invasion; nor the low temperature that is continuously maintained to reduce chemical changes to a minimum and practically suspend bacterial life. If perishable products are properly prepared for cold storage, and properly carried in storage, they will be wholesome and palatable until the following season furnishes a new supply. The most important thing is to get the foodstuffs to the warehouse before decay has begun. That is

the goal toward which the whole industry is working. The careful investigations of the laboratory, supplemented by the application in the field of the fundamental principles governing decomposition, have shown the great economic value of good handling accompanied by refrigeration. The optimum holding temperature, too, must be determined for each class of commodities, and has already been fixed for many classes.

The influence of temperature alone, as a factor governing decay, may be shown by the rate of decomposition in dressed poultry.¹ Chemical and bacteriological analyses of chickens kept for two days at 65° F. to 75° F. showed that putridity had set in, and that they were absolutely unfit for food. Similar chickens kept for 5.5 days at the temperature of a house ice-box, that is, 50° F. to 55° F., were edible, but a little stale. Their fellows, kept 15 days at a temperature of 32° F., were at their optimum for food purposes, and, chemically speaking, had altered in composition far less than the birds in the ice-box. Even after 22.5 days at 32° F. the chemical changes were still less than in the birds kept in the house refrigerator. The chickens were also frozen hard and analyzed at the end of 4, 8, 12 and 16 months, respectively. At the end of 4 months there was practically no change in the chemical composition. At the end of 8 months there was just enough change to be detectable by laboratory methods. There was no change to be detected in the flavor of the flesh. After 12 months hard frozen the chemical changes, as measured by the laboratory, are still a little behind those of the house ice-box after 5.5 days. The flavor is still good but the flavor of the 8 or 9 months bird is better. At the end of the 16 months chemical and organoleptic changes can be observed and while the birds are not putrid, nor can we say positively that they are unwholesome, they have lost some of their palatability and they are not high class foodstuffs. They are by no means, however, as low grade as the chickens kept 2 days between 65° F. and 75° F.

The question of temperature in the handling of eggs is quite as important. Incubation proceeds above 68° F. in the fertile eggs, but more slowly than at the normal temperature of the nest. One day at 103° F. produces the same result as 7 or 8 days at 86° F. to 91° F.,²

¹Hearings, Committee on Manufactures, U. S. Senate, 62d Congress, *Foods Held in Cold Storage*.

²Edwards, "The Physiological Zero and the Index of Development for the Eggs of the Domestic Fowl," in *American Journal of Physiology*, vol. VI, 331-396.

and 24 hours at 107° F. gives a chick equal in development to one incubated for 3 days at 103° F. The same principle holds good for the deteriorative changes which are not accompanied by incubation, but because we cannot carry an egg in the shell hard frozen we cannot retard the downward changes as effectively as in poultry, butter or fish.

There is no egg so good as the perfectly fresh egg. But the city consumer can but seldom get the perfectly fresh egg; and because practically the whole egg output of the year is concentrated into a few months, the consumer of eggs in city or country must, for a part of the year, eat conserved eggs or none at all.

So far as our knowledge goes now a fresh egg, held at temperatures between 29° F. and 31° F., will be an edible, wholesome egg at the end of 9 months. It is not advisable to try to soft-boil or poach an egg which has been more than six months in storage. For all other purposes such eggs are above reproach.

What has been said for poultry and eggs applies to other meats, butter and fish. The articles must be in the pink of condition when they go into the freezer or the chill room; they will then come out in good condition. Cold storage cannot improve foods, except, perhaps, cheese. It can keep good foods good from the season of flush production until the season of scarcity, and that is all any sensible person will ask of it.

There is a firm, if unfounded, belief on the part of the general public that all the undesirable foods on the market come out of the storage warehouses, and that their condition is directly due to storage. A bad egg is blamed on cold storage during the months of April and May, when a storage egg is as rare a phenomenon as snow in the tropics, with the same positiveness that it is in November when there are practically only storage eggs to be had. The truth of the matter is that comparatively little of the foodstuff in storage is condemned as unfit for food, while enormous quantities of so-called "fresh" produce is confiscated and destroyed by the health authorities. Some recent figures may serve to emphasize this point.

During the year 1911 the city of New York condemned in its markets 72,785 pounds of eggs; 350,547 pounds of fish and about 200,000 pounds of poultry. During the months of October to December, inclusive, the inspectors of the State of Massachusetts examined the goods in all the public warehouses of the state, returning a report of

the condition and the quantity of foods stored. On the first day of January, 1913, there were over 43,000,000 pounds of perishable products in storage in Massachusetts, excluding fruit and vegetables. There were, in this total, over 9,800,000 pounds of eggs; 6,169,790 pounds of poultry; 5,211,943 pounds of fish.

The inspectors found it necessary to condemn and destroy a total of about 300 pounds of foods. That is, approximately 138 pounds of poultry, 119½ pounds of fish and one box of pork-loins. The total quantities stored in New York or condemned in Massachusetts are not available, and, therefore, the foregoing figures cannot be compared directly. They do serve, however, as significant indices of the conditions actually prevailing. All the investigations on this subject would tend to show that we are more apt to find that decayed foods are due to bad handling between the producer and the consumer than to cold storage.

It is a difficult matter to estimate the extent of the cold storage industry. The best figures obtainable indicate that there are between 700 and 800 public cold storage warehouses in this country, aggregating approximately 200,000,000 cubic feet of space. About 1,320,000 carloads of perishable products pass through the warehouses in the course of a year, valued at approximately \$600,000,000. These figures do not include the fresh meat which is refrigerated in the packing houses and public markets, and which amounts to 16,000,000 pounds yearly. We have no figures concerning either the space or the products stored in private houses, of which there are probably 2,000. Such figures indicate a great industry and when one remembers that it has developed within the last twenty-five years, its magnitude becomes even more interesting. Such an outlay of effort and capital could only arise in response to a necessity. What is the necessity?

To reply to this question we must consider more fully the state of things hinted at in the opening paragraphs of this paper, namely, the ever increasing distance between the producer and the consumer and the ever increasing scarcity in the food supply because of the rapid increase in urban population, the decrease in new public lands and various other factors. Seasonal products, too, are now in demand the year around, a demand that can be complied with only by conserving the extra production of the flush period.

The productive land in the immediate vicinity of our large cities

is steadily decreasing and will continue to decrease so long as the present tendencies of urban life continue. We can no longer depend upon such territory for food supplies. The middle Atlantic and New England states are fed from the valleys of the Missouri, the Mississippi and the Ohio. The Pacific states, also, draw upon this territory for meat, poultry and eggs. It has been estimated that only 1 per cent of the eggs coming into the cities of Philadelphia, New York and Boston are produced nearby; and 99 per cent come from the western corn belt and Tennessee and Kentucky. It has also been estimated that all the food supply coming to New York City averages a four-day haul by fast freight—that is, about 1,000 miles. For this reason our country has evolved a system of refrigerated carriers to transport, and a system of refrigerated warehouses to preserve, foodstuffs. These are quite as remarkable as the arrangements by which Great Britain imports food for her people and just as necessary.

The great gateways from the west to the east, such as Chicago, St. Louis, Omaha and Buffalo, must be able to receive and conserve the tons upon tons of perishable products that are sent to them during the producing season. The markets would be so glutted, if all the perishable foods that are produced had to be consumed during the season of production, that production itself would be seriously curtailed. On the other hand, the whole nation would be on scant rations during the non-productive season, and prices would soar to dizzy heights. Even if our people could obtain a sufficient amount of food it would be so restricted in variety, so very different from the ample choice now offered in every market, that the consumer would consider himself abused indeed. Only the households of the very wealthy could afford eggs from November to March. Nearly all our butter is made between May and September. The catch of fish from December until March is not worth considering by comparison with the consumption of fish. Beef cattle are marketed throughout the year yet the autumn slaughterings, when grass ends and grain feeding is not advisable, may increase 33 per cent. The supply of fresh beef at that time is too heavy but is needed before grass comes again. Broiling chickens would be in our markets from mid-July to October; roasting chickens from October to January. Outside the months mentioned these commodities are not produced in market quantities. Remember that the little nearby poultry man, or truck farmer, who has one or two early hatches, or a little incubator, and who can give

you, in May or June, squab broilers at one dollar a pair, has no more effect on the food supplies of this nation than has the tiny, never failing spring on the great water supply of the city. But the people have become accustomed to broiling and roasting chickens, eggs, sweet butter, salmon and halibut from the north Pacific, red snapper from the Gulf of Mexico, and other such seasonal or far distant products, and they expect the market to furnish them on demand. This it is doing and has done because of this wonderful system of food transportation and conservation. There is no other way, with our present knowledge of production and conservation, that it can be done.

The statements of the press concerning the length of time that foods are kept in storage are disquieting. An investigation of this question has been made by the Bureau of Statistics, United States Department of Agriculture.³ According to the statement of the statistician, the average storage time for beef is 2.3 months; for fresh mutton, 4.4 months; butter, 4.4 months; poultry, 2.4 months; eggs, 5.9 months; fish, 6.7 months. The quantities kept for more than the 12-month period are negligible and the cause is generally lawsuits or business difficulties involving the owners.

The laboratory tells us that the conserving power of cold is very great. Inspection of the warehouses shows that the sanitation and construction are adapted to the work to be done. In other words, our present system of cold storage is efficient and economic. Yet we find produce rotting on every hand; millions of dollars worth of foodstuffs spoil between the producer and the consumer. The producer is poor and the consumer is both hungry and poor. Foods coming out of storage in prime condition lose freshness and quality by the time the consumer gets them. Why?

The answers to these questions are being sought by a great corps of agriculturists, scientists, economists and financiers. When they are found, and all the remedies applied, there will be no need of such papers as this. Since the questions are under discussion everywhere, let us look briefly at one or two of the fundamental conditions now prevailing between the consumer and cold storage.

The consumer frequently pays exorbitant prices because he demands fresh products when they cannot be obtained in market amounts. On the score of scarcity the dealer quotes a price consider-

³Geo. K. Holmes, "Cold Storage Business Features," in *Bureau of Statistics Bulletin*, 93, U. S. Department of Agriculture.

ably higher than is warranted by the cost of the preserved article, but less than the cost of the fresh article that might be procured from some special producer by special means. The consumer does not know where, when or how the foodstuff was grown and handled for market. He is the dupe of conditions that have passed by and of ideas that would be found unsatisfactory if they were complied with. He has a right to know what he is getting and paying for. The information is all about him in books, pamphlets, lectures and the diverse ways of disseminating knowledge. However, he seems, in this vitally important matter of the food supply, to be content to get his knowledge from the retailers, which—while human nature is human nature—will seldom be a reliable source.

If the consumer will find out what the market can furnish from nearby sources; what goods must be hauled a thousand miles or more; what products are in season and can be obtained fresh and what must be supplied from storage, he will find that the retailer's statements to him will assume quite a different tone, and the prices quoted will bear a closer relation to just profits. The consumer will also find that, by and large, the perishable products shipped in car lots from the western producing regions are in better condition than those produced a hundred miles or so away and handled in the careless fashion of the usual eastern farmer. He will, therefore, lose his preference for nearby supplies. He will find that the hard frozen fish, chicken, butter or other stored article, if taken to his household just as it comes out of the warehouse, will be in good condition, whereas if the retailer is allowed to thaw it out, or otherwise obliterate the signs of storage and permits it to lie around his store while waiting for a customer, it is sure to have lost its high quality and may be exceedingly undesirable. Primarily, then, much of the blame for the present condition of food commodities and prices rests with the consumer. One remedy is the acquisition of knowledge and its application to the everyday retail buying. Generally, the consumer endeavors to shift such responsibility by making laws that are supposed to compensate for ignorance; and this brings us to some phases of the subject that have had legal consideration.

The question of unlawful combinations in the cold storage industry, whereby the quantity of goods on the market might be restricted and prices unduly increased, is a subject that will bear consideration. At the present time the public warehouses are so numerous, so scat-

tered, so diversely owned and managed, that combination would seem to be impossible. Neither do these houses own the goods in them—they are merely depositories. Realizing that information concerning the quantity of foods in storage is necessary to the public welfare as well as a protection to themselves, the cold storage warehouses of the American Warehousemen's Association, now 43 in number, have for years voluntarily furnished monthly statements of the goods carried. This statement is given the widest publicity by trade papers and journals and the United States Crop Reporter. The great corporations handling perishable products, and warehousing enormous amounts, make no statements to anyone. Neither do the owners of the multitude of smaller private refrigerated houses. The aggregate holdings of such is very great and is a factor in the food supply of the nation. The progressive warehousemen have publicly gone on record and have expressed to the United States Government a belief in the necessity for a system of reports giving holdings of foodstuffs, that all the people might know the resources of the nation. A national law to that effect will undoubtedly be made some day.

Meanwhile, the students of cold storage as related to the conservation of foods, and as an indispensable factor in modern life, are simply asking that the many attempts at legislation shall not impede progress; and that the consumer, too ignorant now to know what he ought to have for his own betterment, shall not wake up to find himself injured by legislation that is to his detriment.

There is a need for a broad, general policy in the handling of interstate traffic in perishable products, involving transportation, storage, marketing and the whole vast field of the distribution and conservation of our food supplies. That is a question for the federal, not the state government.

The question of cold storage, which is really conservation, is too much a part of the greater problem to be considered separately. Conservation of foodstuffs is a vital question now, and will lose none of its importance as the years go on if our country continues to develop and to pile up its people in cities. We dare not risk adding to the complexities already confronting us an unjustifiable restriction of the most potent means that we now have for the conservation of perishable products, namely, refrigeration. It is an open question whether, with the rapidly changing conditions, we know enough at this time to make wise regulations.